THE MARINE TRANSPORTATION SYSTEM'S ECONOMIC JUGGERNAUT: A TONIC FOR POLLUTION PREVENTION?[1]

CAPT Mark H. Johnson
U.S. Coast Guard Commandant (G-MWP)
2100 2nd Street, S.W.
Washington, District of Columbia 20593

ABSTRACT: *In September 1999, U.S. Secretary of Transportation Rodney Slater delivered a report on the marine transportation system (MTS) to the U.S. Congress. It captured the growing alarm by MTS stakeholders that the current system of marine transportation was barely adequate now and certainly not capable of accommodating the predicted growth and changing nature of shipping over the next two decades. While the report's recommendations seemed to highlight the economic aspects of the MTS, solving impediments to economic efficiency also can translate into significant pollution prevention. Principal among potential pollution prevention is in the area of reducing the numbers of vessel collisions, allisions, and groundings—29 of which resulted in oil spills of 10,000 gallons or more between 1995–1999. These casualties impact the ability of a port to conduct business, resulting in accrual of demurrage and risking competitive position.*

Attacking the port-specific and systemic factors influencing human factor causes of collisions, allisions, and groundings, the U.S. Coast Guard has embarked on several risk-based decision tools that enable local MTS coordinating committees, called harbor safety committees (HSCs), to evaluate the greatest factors that can contribute to vessel casualties. The tools include a Ports and Waterways Safety Assessment (PWSA) and a tailored model to evaluate U.S. Army Corps of Engineers facility permits. Early results show opportunities to improve navigational risk in specific ports. Additionally, another MTS effort involves providing real-time navigational and environmental information to vessels to aid decision making.

Discussion

In September 1999, U.S. Secretary of Transportation Rodney Slater delivered a report on the marine transportation system (MTS) to the U.S. Congress (DOT, 1999). The report, which was the product of a diverse task force of water transportation stakeholders, concluded an effort directed by Congress to validate concerns about the adequacy of the MTS to accommodate a growing demand for its services. Indeed, the report noted that, "The total volume of domestic and international marine trade is expected to more than double over the next 20 years. The number of recreational users is expected to grow by over 65 percent to more than 130 million annually in the next 20 years" (DOT, 1999, p. viii).

The report painted a bleak picture of a system already seriously strained to provide necessary services to rapidly changing user requirements, such as "time definite" logistics delivery as the next phase in the evolution of "just-in-time" product supply. It bemoaned an inadequate infrastructure of ship/terminal interfaces, dredging and channel design, and information systems that "…cannot safely accommodate the vessels and cargo throughput expected by 2020" (DOT, 1999, p. 43). For oil and chemical terminals, the MTS report warned of an increase risk of spills because of "inadequate mooring arrangements that could cause a breakout from passing large ships in narrow channels" (DOT, 1999, p. 43).

In the area of human factors, the MTS report warned that, unlike the rest of the world, mariners arriving or departing from U.S. ports are saddled with archaic navigation systems (instead of integrated electronic navigation with greater accuracy), no real-time hydrographic information, and a dearth of vessel traffic systems, at a time of record numbers of commercial and recreational craft plying America's restricted waterways. Greater potential for accidents is present as high-speed ferries and high-speed recreational boats—the latter operated by untrained personnel—compete with traditional fishing fleets and large commercial ships on restricted waters.

Although the environmental aspect of the MTS was not ignored in the report, its context is important:

> Environmental quality is essential for sustaining coastal and marine ecosystems, commercial and recreational fisheries, and the economic vitality of the marine transportation system. The health of coastal and marine ecosystems is affected by water quality, and in turn, water quality depends upon ecosystem health. There is a clear relationship between environmental protection and MTS efficiency and safety. Improving MTS efficiency and safety will reduce risks to the environment (DOT, 1999, p. 53).

Economics drive the MTS. The MTS report highlighted six critical issues—coordination, safety, competitiveness, national security, infrastructure, and environment—that must be improved to propel the MTS to the desired end state. But as the above quote shows, the *economic vitality* of the system is of paramount importance. This is not a bad thing if one is trying to prevent oil spills.

Efficiency and safety will improve only if MTS users can reduce the risk of accidents, specifically collisions, allisions, and groundings. From 1995–1999, 47 vessel spills of greater than 10,000 gallons occurred. Of those, 29 were the result of a collision, allision, or grounding[2]. Further, historical evidence shows that these types of casualties typically are caused by human factors. While human factors can encompass physical subfactors like fatigue and improper training, they also can include environmental influences such as weather, current, visibility, and navigational awareness. The second set of subfactors can be influenced by systemic deficits, such as outdated charts and faulty situational awareness, as well as port-specific factors, such as blind spots in channels and large numbers of fishing or recreational boats in the harbor. The MTS initiative seeks to interrupt the casualty causal chain to prevent the collisions, allisions, and groundings that negatively impact both the economic and environmental aspects of marine transportation.

Fortunately, the MTS economic driver presents the opportunity to reduce overall casualty risk to the system, with specific applicability to human factors. Generally, economic incentives can be grouped into two camps. First, collisions and groundings will cause closure of the affected waterway until successful salvage can be performed. In countless cases, U.S. Coast Guard Captains of the Port (COTPs) routinely issue orders preventing ships and tugs and tows from passing a stranded vessel or the scene of a collision. As shown in 29 of these cases, the casualty also resulted in additional risk through discharge of fuel or cargo oil. At the moment such an order is given, demurrage accumulates on the affected vessels and port terminals.

Demurrage is the financial penalty for not conducting business and is normally a fixed daily sum. Even a moderately busy port that suddenly is unable to conduct business accrues tremendous local and regional costs. For example, in 1998, the port of Savannah, Georgia generated $63 million per day in revenue[3]. Closure of that port for any substantial amount of time would quickly impact the local and state economies. Not only that, but the definite nature of shipping guarantees broad, trickle-down disruptions from cargo interruptions and stockouts for manufacturers, to lack of crude oil for refineries and heating oil supplies for consumers.

Even though those causing the demurrage may become liable to the affected parties, a port with a reputation for accidents, and thus delay, puts itself at a competitive disadvantage to its regional peers. Likewise, a shipping line with a reputation for accidents puts itself at great competitive disadvantage with the many other similar lines. Nowadays, no one can afford economic disruption caused by marine casualties.

The improvements called for in the MTS initiative clearly hope to avoid lost business and chargeable demurrage as a result of marine casualties that could close down a port or waterway, even for a short time. This efficiency also results in substantial pollution prevention benefits through reduction of the primary cause of large oil spills.

While the MTS initiative is in its infancy, several projects launched by the Coast Guard—which is 1 of the 17 federal agencies committed to MTS improvement—have direct safety relevance that should lead to a reduction in marine accidents, as described below.

MTS decision tool: harbor safety committees

The MTS report to Congress (DOT, 1999) recommended improved local coordination among port stakeholders (public and private), generally through harbor safety committees (HSCs). While many large ports have HSC elements, many smaller ports do not. HSCs are port-level coordinating bodies of harbor and waterway users. Typically, HSC representation includes pilots, Coast Guard representatives, terminal operators, shippers, tug companies, agents, marine exchanges, U.S. Army Corps of Engineers (ACOE) representatives, and National Oceanic and Atmospheric Administration (NOAA) representatives. These committees provide an excellent forum for discussing and agreeing to actions that can reduce navigational risk. As such, they were featured as a direct recommendation in the report to "encourage the creation of Harbor Safety Committees and regional organizations, where appropriate, to address local concerns" (DOT, 1999, p. 72). The Coast Guard responded by publishing Navigation and Vessel Inspection Circular (NVIC) No. 1-00 (USCG, 2000a), which contains recommendations on organization, membership, and issues to consider. One issue was Safety and Environmental Protection:

> Under this strategic area, HSCs are specifically called on to serve as local committees able to pursue safety and environmental concerns related to the MTS and develop and execute collective actions…The mission of the existing harbor safety committees…could be expanded to conduct comprehensive assessments of local safety and environmental risks and needed actions.
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> Safety and environmental protection issues include ship channel configuration, ship terminal interface, port/terminal development and operations…vessel operations and the human element, pollution sources…(USCG, 2000a, pp. 8–9).

MTS decision tool: Ports and Waterways Safety Assessment

Seizing on the direction to assess local safety and environmental risks, NVIC No. 1-00 noted that local COTPs could coordinate use of risk-based decision tools by HSCs. Prominent among these tools was the Ports and Waterways Safety Assessment (PAWSA) (USCG, 2000a, p. 10). PAWSA grew out of a congressionally terminated, Coast Guard vessel traffic system program, VTS 2000. In terminating VTS 2000, Congress directed the Coast Guard "to identify minimum user requirements for new (vessel traffic management) measures...in consultation with local officials, waterways users and port authorities" (1997 U.S. Department of Transportation Appropriations Act). As a result, the Coast Guard established the Ports and Waterways Safety System (PAWSS) to address waterway user needs and place a greater emphasis on partnerships with industry to reduce risk in the marine environment.

One tool within that system was PAWSA. Seizing on its risk-based modeling potential, the Coast Guard has allowed the tool to become a tangible MTS vehicle for local navigation safety improvement. In many U. S. ports, there is a dynamic tension between safety and efficiency, and a structured risk assessment process has not been available or utilized to resolve the tension. To be successful, the MTS initiative must manage U. S. waterways to allow for both safe and efficient movement of all classes of vessels, generally through cooperative action by government and private stakeholders. PAWSA facilitates that cooperative action.

The PAWSA model consists of panels of experts within a specific port or waterway applying a generic vessel casualty risk process. The process model "includes variables dealing with both the causes of vessel casualties and their effects. Once the model parameters have been established, the vessel casualty risk in an individual port (or waterway) is estimated by inputting values for the variables specific to that port into the risk model" (USCG, 2000b, p. 7). The six variables or factors are:

- Composition of the calling fleet (percentage of high risk deep draft vessels and of shallow draft vessels)
- Traffic conditions (traffic density, volume of deep- and shallow-draft vessels and fishing and pleasure vessels)

- Navigational conditions (wind, visibility, currents, tides, ice)
- Waterway configuration (visibility obstructions, passing arrangements, channel and bottom conditions, waterway complexity)
- Short-term consequences (number of people on waterway, volume of petroleum cargoes, volume of hazardous chemical cargoes)
- Long-term consequences (economic impacts, environmental impacts, health and safety impacts)

When conducted in several of the ports over the past year, the PAWSA model yielded such observed results as unification of a port community, formalized risk management, and serving as a catalyst for establishment of local HSCs where none exist. Specific results showed even more system promise as an accident prevention tool from a port systems approach.

San Juan, Puerto Rico. Here, the greatest port risks occurred because of the percentage of high-risk deep-draft vessels operating in a high traffic density environment, with frequent strong wind impact on narrow channels. This necessitated one-way traffic without a skilled entity to provide suitable passing instructions. Additionally, large volumes of petroleum move through the harbor, putting environmentally sensitive areas further at risk. As a result of the PAWSA model, several immediate actions were instituted to reduce risk, including the following: Commonwealth of Puerto Rico improvements in port control personnel capability; COTP facilitation of port community guidelines for things such as standby tug use, pilot rules, improved communication, and information exchange; and public outreach to the recreational boating community on navigation safety (USCG, 2000c, pp. 7–A13).

Port Arthur, Texas. In contrast to San Juan, the greatest risks in Port Arthur were from increasing volumes of shallow-draft vessels, particularly for a portion of the channel shared with the Intracoastal Waterway and its barge traffic. This impacted petroleum and chemical-laden deep-draft vessels that were struggling with strong currents, fog, and several blind spots on their channel transit. The principal risk mitigation in the view of the participants was a vessel traffic system (USCG, 2000d, pp. 3–A5).

In many cases, the PAWSA results to date show improvement of existing practices can significantly reduce risks. In other cases, infrastructure improvements like vessel traffic system installation or dredging of channels are needed for risk reduction. But with the benefit of a structured model and expert participation, improvements that require outside budgetary support are more easily justified. Initial success of the PAWSA model has led the Coast Guard to plan for PAWSA use in all the COTP zones as a coordination and safety part of the MTS initiative.

MTS decision tool: ACOE structure and facility permits

A similar Coast Guard risk-based approach to safety improvement for reducing collisions, allisions, and groundings concerns ACOE permits for structures and facilities adjacent to and on the navigable waters of the United States. These structures can be as benign as a homeowner's dock to a major marina, a new oil terminal, or a floating casino vessel mooring. With an eye to interagency coordination called for in the MTS report to Congress (DOT, 1999), and the employment of risk-based decision making regarding the MTS, the Coast Guard and ACOE signed a Memorandum of Understanding (MOU) that solidifies Coast Guard input to the ACOE approval process. The MOU mandates that the Coast Guard conduct a risk assessment of the planned structure, and calls for periodic reevaluations of previously issued permits if the nature of the waterway has changed. To assist with the implementation of the MOU, the Coast Guard has developed a tailored risk model to assist with the evaluations, with inputs in the following areas:

- Physical location (proximity to channel, on a channel bend, proximity to population centers)
- Impact on the Waterway and Port Operations (change in traffic volume or cargo volume, impact on aids to navigation, effect on adjacent facilities)
- Weather and environmental conditions (fog, winds, tidal ranges, currents)
- Severity (potential safety, environmental, and/or economic impact of a potential mishap with tiered consequences within each category)
- Likelihood (related to severity tiers, either increasing or reducing)

The model calculates a risk index number for each area relative to the existing risk and produces a cumulative risk percentage that the COTP or HSCs can use in their recommendations to the ACOE. Clearly introduction of new facilities and their related vessel traffic can affect the numbers of allisions and collisions. Use of a structured model allows ports to evaluate what conditions might be necessary to support construction of new facilities with an acceptable level of risk.

HSCs in ports like Pittsburgh, Pennsylvania already have established subcommittees to provide a broader-based port stakeholder risk assessment to high-profile permit applications. This presents an ideal confluence of interstakeholder coordination with navigational risk reduction, both tenets of the MTS initiative.

Other MTS decision tools

As mentioned previously, the MTS strategic areas of focus include safety and environmental protection. Within the environmental protection area, specific recommendations included evaluating port oil and chemical waste discharge needs, and upgrading facilities to accommodate projected demand. Often discrepancies between facility need and facility use stem from economic factors (DOT, 1999, p. 95). Ships that regularly do not discharge oily waste are increasing the risk of accidental (or intentional) discharges into the marine environment. Again, the HSCs provide an excellent venue for these discussions, highlighting the coordination criticality for achievement of MTS success.

Yet another example of an MTS initiative with direct relevance on navigational safety—and thus an opportunity to reduce collisions, allisions, and groundings—has to do with the availability of real-time information to arriving and departing vessels within a port. The national task force that drafted the MTS report to Congress said this about the need for timely navigational information:

> Task Force members identified the need to establish a safety information infrastructure. Real-time environmental and waterway situational information is essential to safe navigation and competitive use of our waterways. As the average size of today's commercial ships continues to grow, the margins between their keels and channel floors decreases. Maneuverability is increasingly restricted, raising the risk of oil spills and accidents involving other hazardous materials…Because of uncertainty about tides and currents, large commercial vessels are delayed in port and offshore as they await optimal transit conditions. Such real-time information is also instrumental in preventing and responding to spills of

hazardous materials and oil, predicting coastal flooding, and conducting scientific research (DOT, 1999, p. 44).

Note the theme between environmental efficacy and economic efficiency. The safety information structure called for by the task force envisioned an intelligent transportation system consisting of "…a collection of electronic communication and information systems…that provide the means for collecting,…disseminating the information required by all MTS stakeholders and users" (DOT, 1999, p. 66).

From a ship's perspective, intelligent transportation could mean actual weather, tidal height, current direction, velocity, salinity, and channel water depth as well as depth alongside the intended pier; incredibly accurate satellite-based precision navigation position that is unaffected by visibility; and an accurate picture of all other vessels sharing the waterway. It is easy to see how possession of this information by a vessel's pilot or crew can reduce the risk of human factor failures associated with the uncertainty of vessel position, environmental elements, and other vessel locations.

Incorporating the NOAA Physical Oceanographic Real-Time System (PORTS), ACOE channel depth soundings and dimensions, and private terminal soundings of depth alongside piers with immediate electronic updates to navigational charts, and integrating automated identification system of vessels into shipboard bridge management is another aggressive Coast Guard initiative currently underway. Though clearly the end product will be a multistakeholder effort, Coast Guard studies of user requirements and available data systems that could populate a data warehouse signal the start of applying technology to reduce human factor navigational risk. The MTS report to Congress portended the potential of this initiative: "Tide, current, water level and meteorological information available via PORTS have already been credited with preventing groundings…" (DOT, 1999, p. 32). The technology application also has the economic benefit of permitting more precise cargo loading and timing to maximize product throughput for the least overhead cost.

Conclusions

Taken individually, each of the examples presented in the paper would result in improvement within a sector of the marine transportation system that would lead to a reduction in accidents yielding oil spills. Absent a bell weather event that leads to national statute to prevent spills from a systems perspective, the limited sector improvements are historically the pollution prevention trackline that has been followed. Sector improvements, though, result in marginal improvement. However, signal events such as the Clean Water Act of 1972 or the Oil Pollution Act of 1990 (OPA 90) can cause substantial system-wide, pollution prevention change, forced by legislative fiat and the threat of monetary penalties or criminal incarceration.

What is of particular note regarding the role the MTS initiative can play in the prevention of significant oil spills is it is progressing without *any* legislative mandate or support. Rather, under Department of Transportation leadership, all public and private stakeholders have agreed to work collectively on the system to improve its capacity, effectiveness, and efficiency so that marine transportation in the United States can be the world's leader. Capacity, effectiveness, and efficiency are economic drivers, by-products of which include security and environmental protection. But because of the broad-based user commitment to MTS improvement, the pollution prevention potential—principally through reduction of vessel collisions, allisions, and groundings—could rival OPA 90 for impact. This would innovatively be accomplished not through the negative reinforcement of penalties, but rather the positive reinforcement of economic profit.

References

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[1] The views and opinions expressed in this paper are solely those of the author and do not necessarily reflect the official positions or policy of the U.S. Coast Guard.

[2] A collision occurs when two moving objects strike each other. An allision results when a moving object strikes a fixed object like a pier. Casualty Statistics 1995–1999, U.S. Coast Guard Commandant (G-MOA), Washington, D.C.

[3] Statewide Economic Impact, FY 1998, Georgia Ports Authority, available on-line at *http://www.gaports.com/statistics.html*.